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MEMORANDUM

To: Dr. Michael A. Anderson, P.E.   1801-03
From: B.P. Doty
Date: September 11, 1989

Subject: Hydraulic Remedial Actions
          Medium Priority Sites IRA

This memorandum describes hydraulic remedial actions under consideration for the 903 Pad, Mound and East Trenches Areas at the Rocky Flats Plant. The areas are located adjacent to each other on the western edge of the east buffer zone but have very different hydrologic characteristics.

o   The 903 Pad area is located on the Rocky Flats surface and extends to the south onto the slope toward Woman Creek. Much of the underlying soils are unsaturated. The major area of volatile organic contamination is on the hillside and may be a release from a unit within the area known as Trench T-2. Contaminated ground water is found primarily in shallow sandstones on the hillside; soils on the hillside are apparently saturated on only an intermittent basis.

o   The Mound Area is located on the Rocky Flats surface; the soils are thinly saturated and are apparently continuously underlain by claystone. Volatile organics are found in the ground water in the Rocky Flats Alluvium.

o   The East Trenches area is located on the Rocky Flats surface; as much as 12.5 feet of the soils are saturated in some areas and the soils are highly permeable. Only the western group of the East Trenches is considered in this memo because the eastern group appears to be only a minor source of contamination. Soils beneath the western group of the East Trenches appear to be directly underlain by sandstone bedrock of the Arapahoe Formation. Volatile organic contamination occurs in the ground water in both the soils and the bedrock.

The following sections discuss hydraulic remedial alternatives for each of these areas.

ALTERNATIVE 1.   PUMP EXISTING WELLS

Ten existing wells have been selected as candidates for pumping (Table 1). The wells were selected because they have volatile organic concentrations of more than 500 micrograms per liter (ug/l). The most contaminated well in each area will be pumped for 30-days in order to collect the most contaminated water immediately and to allow a period for equipment start-up.   During the next 30-day period, the original wells plus the next most-contaminated wells will be pumped. This scheme is illustrated on Table 2.

The wells will be maintained in a fully dewatered condition. Either centrifugal or air-actuated pumps will be used.   The pumps will be controlled with conductivity liquid level controllers.   Discharge will be piped to new tankage for temporary storage prior to treatment at the 881 Hillside treatment plant (expected to be operational in December, 1990).

ALTERNATIVE 2.   THREE FRENCH DRAINS

French drains will be constructed at each of the areas to collect contaminated alluvial ground water. The approximate lengths, depths and expected ground-water production are shown on Table 3. The drains will be constructed similarly to that proposed for the 881 Hillside. The key elements of the design are as follows.

o   Drain fully penetrates the soil and keys into low permeability bedrock.

o   Downgradient side of drain is covered with a synthetic membrane to reduce the amount of clean water entering the drain from the downgradient side of the drain.

o   Ground water collected in the drain will flow by gravity
     to at least one sump (additional sumps may be required in
     areas where the top of bedrock undulates).

o   The sumps will be kept essentially dewatered using liquid
     level controlled submersible pumps.

o   The collected ground water will be stored in temporary
     tankage prior to treatment at the 881 Hillside treatment
     plant.

French drain control of contaminated ground water at any of
the areas is not considered feasible at this time.   The
reasons for this are as follows.

o   The drain at the west East Trenches is likely to be
     ineffective because sandstone subcrops beneath most of the
     area (poor bottom seal) and the subcropping sandstones
     contain significant concentrations of volatile organics
     (poor control of existing contamination).

o   The drain at the 903 Pad is also likely to ineffective
     because the soils are mostly unsaturated and the real
     problem occurs in the bedrock.

o   Although, the drain at the Mound area is likely to be
     quite effective because the area is underlain by claystone
     and there does not appear to be a bedrock contamination
     problem, it also is considered likely to be ineffective
     because the true extent of contamination in the alluvium
     is not yet known. A french drain in this area will be re-
     evaluated after completion of the Phase II remedial
     investigation.

ALTERNATIVE 3.   THREE LINES OF PUMPING WELLS

Three lines of pumping wells will be constructed at each of
the areas in the same locations as the french drains to
collect contaminated alluvial ground water.   The approximate
depths, number, spacing and expected ground-water production
of the wells are shown on Table 4.   The key elements of the
design are as follows.

o   Wells fully penetrate the soil and key into low
    permeability bedrock.

o   The wells will be kept essentially dewatered using liquid
    level controlled submersible pumps (air-actuated or
    standard centrifugal).

o   The collected ground water will be stored in temporary
    tankage prior to treatment at the 881 Hillside treatment
    plant.

Control of contaminated ground water at any of the areas using
lines of pumping wells is not considered feasible at this
time. The reasons for this are as follows.

o   Wells at the west East Trenches are likely to be
    ineffective because sandstone subcrops beneath most of the
    area (poor bottom seal) and the subcropping sandstones
    contain significant concentrations of volatile organics
    (poor control of existing contamination).

o   Wells at the 903 Pad are also likely to ineffective
    because the soils are mostly unsaturated and the real
    problem occurs in the bedrock.

o   Wells at the Mound area are considered likely to be
    ineffective because the true extent of contamination in
    the alluvium is not yet known.   If the extent of
    contamination were known, wells might be effective because
    the area is underlain by claystone and there does not
    appear to be a bedrock contamination problem. Therefore,
    a line of pumping wells in this area will be re-evaluated
    after completion of the Phase II remedial investigation.

Table 1. Characteristics of Existing Wells

Area	Well	Sum of Volatiles (ug/l)	Completion Material	Hydraulic Conductivity (cm/s)	Saturated Thickness (ft)	30-Day Average Flow (gpm)
903 Pad	1-71	3,700	Bedrock?	5×10^{-4}	15	1.5
	2-71	20,000	Bedrock?	5×10^{-4}	14	1.3
	11-87BR	1,575	f.g. Sandstone	5×10^{-4}	3.2	0.079
	12-87BR	1,105	f.g. Sandstone	5×10^{-4}	2.8	0.061
Mound	15-87	2,622	sandy Gravel	1×10^{-3}	3.4	0.17
	1-74	42,000	Bedrock?	4×10^{-5}	.8	0.046
East Trenches	42-86	2,875	sandy Gravel	2×10^{-2}	12.3	33
	3-74	1,245	Bedrock?	4×10^{-5}	4	0.012
	25-87BR	550	m.g. Sandstone	5×10^{-4}	20.2	2.7
	36-87BR	4,000	f.g. Sandstone	3×10^{-4}	31.2	3.9

Notes:

1. Sum of Volatiles are rough averages of data through second quarter 1988.

2. Questioned completion material descriptions are based on a comparison of potentiometric data and the top of bedrock elevation. f.g. = fine grained; m.g. = medium grained.

3. Hydraulic conductivities based on test results for 1-74, 42-86, 25-87BR and 36-87BR. All others are estimates based on material descriptions in drilling logs (11-87BR, 12-87BR and 15-87) or on estimates of probable material in which the wells are completed (3-74, 1-71 and 2-71).

4. 30-day average flows calculated using variable flow to constant drawdown well and assuming that drawdown is equal to the saturated thickness. Although the flow can be expected to drop as much as an additional 15 percent to reach steady state, these flowrates are conservative and can be used for conceptual design.

Table 2.   Illustration of Pumping Scheme - Pump Existing Wells

First 30 Days

Area	Wells	Flow (gpm)	30-Day Volume (gals)	Volume To-Date (gals)
903 Pad	2-71	1.3		
Mound	1-74	.046		
E. Trenches	36-87BR	3.9	226,627	226,627

Second 30 Days

Area	Wells	Flow (gpm)	30-Day Volume (gals)	Volume To-Date (gals)
903 Pad	2-71	1.3		
	1-71	1.5		
Mound	1-74	.046		
	15-87	.17		
E. Trenches	36-87BR	3.9		
	42-86	33	1,724,371	1,950,998

Third 30 Days

Area	Wells	Flow (gpm)	30-Day Volume (gals)	Volume To-Date (gals)
903 Pad	2-71	1.3		
	1-71	1.5		
	11-87BR	.079		
Mound	1-74	.046		
	15-87	.17		
E. Trenches	36-87BR	3.9		
	42-86	33		
	3-74	.012	1,728,302	3,679,301

Fourth 30 Days

Area	Wells	Flow (gpm)	30-Day Volume (gals)	Volume To-Date (gals)
903 Pad	2-71	1.3		
	1-71	1.5		
	11-87BR	.079		
	12-87BR	2.8		
Mound	1-74	.046		
	15-87	.17		
E. Trenches	36-87BR	3.9		
	42-86	33		
	3-74	.012		
	25-87BR	2.7	1,965,902	5,645,203

Table 3. Summary of French Drain Performance Features

Area	Subsurface Material	Length (ft)	Depth (ft)	Conduc-tivity (cm/s)	Sat'd Thick-ness (ft)	Flow rate (gpm)
903 Pad	Colluvium	920	15	1x10-4	2	0.18
Mound	Rocky Flats Alluvium	200	20	1x10-4	6.5	0.22
East Trenches	Rocky Flats Alluvium	930	25	1x10-2	5	6.3

Notes:

903 Pad drain is assumed to traverse only colluvium; however, the eastern end will traverse a short distance of Rocky Flats Alluvium. Therefore, the hydraulic conductivity value used is appropriate for gravels in the colluvium (881 Hillside value) although gravels are not believed to be present. In addition, it is assumed that two feet of saturation will be found along the entire length of the drain, whereas data indicate the colluvial soils on the hillside are unsaturated.

Flow rate is approximately the 60-day average flow rate as predicted by the expression for variable flow under constant drawdown to a trench. The constant drawdown was assumed equal to the saturated thickness and the storage coefficient was assumed to be 0.1. Although the flow rate can be expected to continue to decline to steady state, the above values are suitable for conceptual design.

Table 4. Summary of Performance of Lines of Pumping Wells

Area	Conduc-tivity (cm/s)	Sat'd Thick-ness (ft)	Well Depth (ft)	Number of Wells	Spacing (ft)	Length of Control (ft)	Draw-down at 1/2 Spacing (ft)	Flow from all Wells (gpm)
903 Pad	1x10-4	2	15	20	48	920	0.1	0.12
Mound	1x10-4	5	20	4	67	200	0.4	0.25
East Trenches	1x10-2	6.5	25	10	103	930	1.1	30

Notes:

Hydraulic properties are justified on Tables 1 and 3.

The number of wells and spacings were estimated by first calculating the average 30-day flow to a single constant drawdown, variable flow well and then predicting drawdowns after 45 days using the average flow as a constant flow in the Theis equation. Storage coefficient was always assumed equal to 0.1. The length of control was divided by the spacing to yield the number of wells needed. Then an additional well was added so that there will be a production well at each end of the control length.

The drawdown at the 1/2 spacing (24 feet for the 903 Pad wells) was calculated using the 30-day average flow after 45 days of pumping.

The flow from all wells is the 30-day average flow multiplied by the number of wells needed to provide the length of control, without regard to interference effects. Therefore, these flow rates are considered conservative and are appropriate for conceptual design purposes.